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LIGHTHOUSES AND TELEGRAPHS.

THE fearful wreck of the *Schiller*, on the Scilly Islands, has attracted considerable attention not only to the mode of signalling the arrival of ships, but to the want of communication between outlying rocks and islands with the mainland. It was customary for all American mail steamers to approach the Scilly Islands in order to have their arrival instantly telegraphed to Plymouth and other places, and at night time to announce their approach by firing a gun or guns; but the latter practice has ceased for about two years, owing to the stringent orders issued against it by the Board of Trade, acting under the provisions of the Merchant Shipping Acts. The former practice still remains, and it is apparently owing as much to the desire to sight the Scilly Isles as to the absence of the use of the lead that this frightful disaster has occurred. How far it is advisable for mail and passenger steamers to approach such a dangerous neighbourhood as that of Scilly to impart an hour or two earlier information of their arrival is a matter for the consideration of their owners and navigators. It appears to us that the Lizard is in many respects a far superior point to make. It is safe of approach, the direction of the tidal stream guides the ship up Channel and clear of danger, the lead is a sure guide of position, and a well-equipped signal-station announces arrival.

Mr. Pendarves Vivian, M.P., proposes to call the attention of the proper authorities to the fact that by connecting isolated lighthouses, by telegraph, with the nearest land, many lives may be saved and much suffering at times avoided after a shipwreck has occurred. He instances the *Schiller* as a case in point. From a letter which appeared in a local paper from the chief lighthouse-keeper at the Bishop, it seems that at 11.30 P.M. on the night of the wreck he was called up by his mate and informed that a steamer was on the rocks, her lights being discernible from the gallery. Nothing, however, could be done, as they possessed no means of communication with St. Mary's, where the lifeboat was kept. The following morning, at half-past 6 o'clock, they could see the unfortunate vessel with her rigging full of people; but before 8 o'clock, when assistance reached her, the masts were carried away, and the greater portion of that living mass was engulfed in the heavy ground-sea. It must, Mr. Vivian says, from these facts be apparent that had the means of communication with the lifeboat station at St. Mary's existed assistance would have been afforded soon after midnight, the sea being in no wise too heavy for the lifeboat to do her part. In all probability, therefore, by far the greater portion of those valuable lives would have been saved. He thinks that the question of expense should not stand in the way of the richest and greatest maritime nation in the world, and conceives that after the first cost of laying the cable the cost of maintenance would be trifling. Unfortunately John Bull studies expense as much as one of his meanest tradesmen, and the terrible uproar which has been caused in his Treasury because the postal telegraphs only pay a small dividend on the purchase-money—instead of the handsome dividends paid to the telegraph companies—is an instance how the richest nation in the world is governed by commercial and mercenary principles The cost of connecting rocky outlets with the mainland would be very considerable. Rocky bottoms require strong and massive cables. Strong and massive cables—however strong and massive they may be—are not infallible. Powerful tides, rough seas, rugged shores, rocky bottoms, soon destroy them. Cables will break, and when they do break their repair is very costly. It would cost over one thousand pounds to connect Bishop's lighthouse with St. Mary's. It would cost some hundreds a year to maintain it in working order. Multiply this sum for every lighthouse around our coasts—for there is no reason why one light should be so communicated with more than another—and see what a figure the country would have to pay, and for what? To obtain assistance on rare and very exceptional occasions, when assistance probably cannot be rendered, and on occasions which ought never to arise. Structures which require the aid of abnormal energy to maintain them in working order are very liable to fall into decay when this energy is not constantly exercised. Life-saving apparatus is frequently out of order when wanted. Lighthousemen can work simple telegraph instruments as well as pointsmen and porters on railways. Call-bells—such as those used in fire-engine stations—can be placed in the room of the nearest lifeboat coxswain, or some other authority. But would they be in order when wanted? And if frequent false alarms were raised, to try their efficiency, might not the frequent cry of "wolf" probably cause their failure at the critical moment?

Telegraphy can be placed to no nobler purpose than that of the protection of human life and the alleviation of human suffering. In this proposal to connect our lighthouses with the mainland there is little prospect that such purposes can be effected. There is an absence of that abnormal energy, either commercial or practical, which is required to maintain the communications in order, and there is no absolute proof that if they were in order they would be of any practical use.

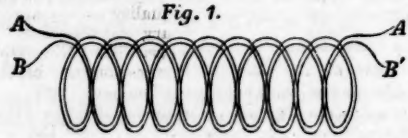
EXPERIMENTS TO ASCERTAIN THE CAUSE OF STRATIFICATION IN ELECTRICAL DISCHARGES IN VACUO.*

By WARREN DE LA RUE, HUGO W. MÜLLER, and WILLIAM SPOTTISWOODE.

(Concluded from page 114.)

For the experiments detailed below, vacuum-tubes were generally used of about 1½ to 2 inches (3·8 to 5 c.m.) in diameter, and from 6 to 8 inches (15·24 to 20·32 c.m.) long; also prolate spheroidal vessels

Fig. 1.



6 inches by 3 inches (15·24 by 7·62 c.m.). The terminals are of various forms, and from 4 inches to 6 inches (10·16 to 15·24 c.m. apart, and made of aluminium, and occasionally of magnesium and of palladium; the latter showing some curious phenomena with a hydrogen residual vacuum, which will be described in a future paper. A tube which has given the most striking results is 8 inches (20·32 c.m.) long, and has a series of six aluminium rings varying in diameter from ⅜ of an inch to about 1¼ of an inch (0·95 to 3·17 c.m.), the thickness of the wire being about $\frac{1}{16}$ (0·16 c.m.) of an inch; the rings are a little more than 1 inch (2·54 c.m.) apart, and connecting wires of platinum pass through the tube from each ring, and permit of the length and other conditions of the discharge being varied.

At times the terminals of the battery were placed in connection with accumulators of different kinds—for instance, two spheres of 18 inches (45·72 c.m.) in diameter, presenting each a superficies of 7·07 square feet (65·68 square decims.), and cylinders of paper covered with tinfoil, each having a surface of 16 square feet (148·64 square decims.); the globe and cylinders were in all cases carefully insulated. Other accumulators were composed of coils of two copper wires $\frac{1}{16}$ of an inch (0·16 c.m.) in diameter, covered with gutta-percha, in two folds, $\frac{1}{32}$ of an inch (0·08 c.m.) thick. One coil contains two wires, A A′ and B B′ (Fig. 1), coiled side by side, each being 174 yards (159 metres) long; another with two wires, each 350 yards (320 metres) long: of the latter we have two coils.

Fig. 2.

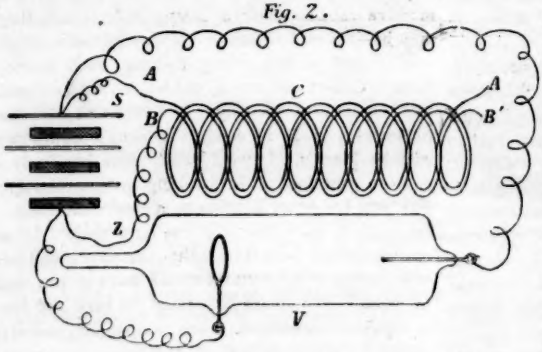
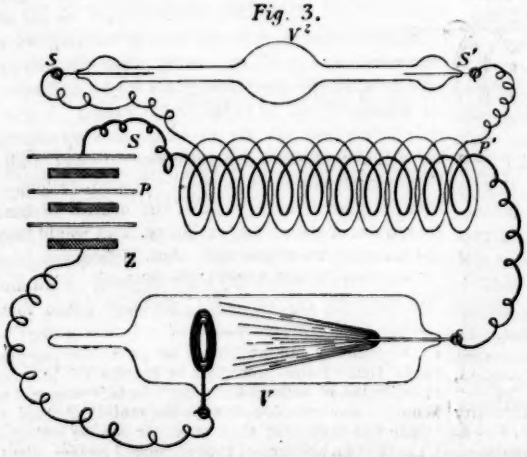


Fig. 3.



In addition to these accumulators we have several others formed of alternate plates of tinfoil and insulating material, such as paper saturated with paraffin, and also sheets of vulcanite. These are of various capacities, and contain from 5 to several hundred square feet. The largest has a capacity of 47·5 microfarads; when it is discharged it gives a very bright short spark, accompanied by a loud snap; the charge deflagrates 8 inches (20·32 c.m.) platinum wire, 0·005 inch (0·127 m.m.) in diameter, when it is caused to pass through it. Each accumulator gives different results, but for the present we shall confine ourselves to a description of the experiments made with the coil accumulators.

When the terminals of the battery are connected with the wires of a vacuum-tube which permits of the passage of the current, the wires (especially that connected with the zinc end) become surrounded with a soft nebulous light, in which several concentric layers of different degrees of brilliancy are seen: in most cases there is either no indication of stratification, or only a feeble ill-defined tendency to stratification: the tubes selected for these experiments were those in which the stratification did not appear at all.

When the battery, already in connection with the vacuum-tube, was also joined, as in Fig. 2, on to one or more coil-condensers (coupled to introduce a greater length of wire, then immediately well-defined stratifications appeared in the vacuum-tube.

In Fig. 2 S Z represents the battery, V the vacuum-tube, C the coil-condenser; a terminal is connected with the end A of the wire A A′, and the other

* A Paper read before the Royal Society.

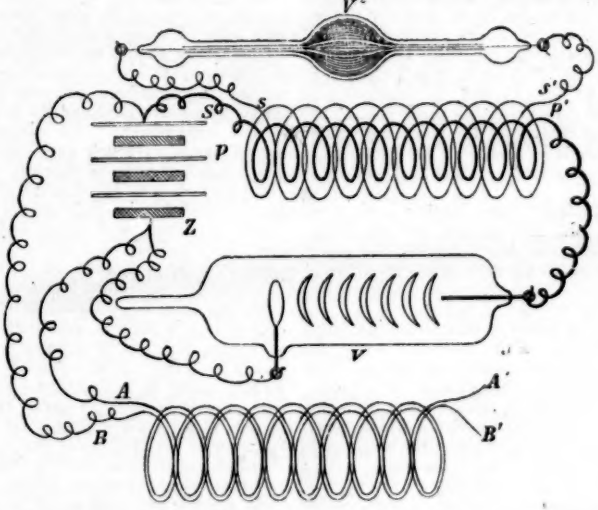
terminal with the end B of the second wire B B'; connections are also led to the wires of the vacuum-tube. The ends A' and B' are left free, and it is clear that the coil forms a sort of Leyden jar when thus used: an interval, however short it may be, must elapse in accumulating a charge which at intervals discharges itself and causes a *greater flow* in the vacuum-tube in addition to that which passes continuously. It may be stated that the capacity of the accumulator has to be carefully adjusted to prevent any cessation of the current,—to avoid, in fact, a snapping discharge at distant intervals. The periodic overflows, so to speak, which increase the current from time to time, would seem to have a tendency to cause an interference of the current waves, and to produce nodes of greater resistance in the medium, as evinced by the stratification which becomes apparent. To the eye no pulsation in the current is apparent; and in order to convince ourselves whether or not there was consequently no induced current in the secondary wire, s s', of the induction-coil.

In the second experiment wires were also led from the terminals of the battery (all other things remaining as before) to the coil accumulator, as in Fig. 4; then, immediately, the discharge in v became stratified, and the secondary vacuum-tube, v^2, lighted up, clearly showing that under these circumstances a fluctuation in the discharge really occurs on the appearance of stratification.

The brilliancy of the discharge in v^2 (the induced current passes through complicated vacuum-tubes through which the primary current cannot pass) depends greatly on the quality and quantity of the discharge in the primary vacuum-tube, v. Under some circumstances the secondary discharge is extremely feeble, and the illumination in v^2 barely visible; under others it is very brilliant.

Preparations are being made to render evident induced currents in the secondary wire of the coil

Fig. 4.



really any fluctuation in the current when the apparatus was thus coupled up with the battery, we made several experiments, and ultimately hit upon the following arrangement:—

The primary wire, *p p'* (Fig. 3), of a small induction-coil, both with and without the iron core, was introduced into the circuit, as well as the vacuum-tube v; to the secondary wire, s s', of the induction-coil was connected a second vacuum-tube, v^2. Under these circumstances there was no change in the appearance of the discharge in v, in consequence of the introduction of the induction-coil, the terminals being still surrounded by the soft nebulous light before spoken of; no luminosity appeared in the second vacuum-tube, v^2, in connection with the secondary wire of the induction-coil, except on making and breaking the connection with the battery. At other times there was evidently no fluctuation in the continuous discharge, no periodic increase or diminution of flow, and too feeble to produce any illumination. Pending the further development of our investigation, we have ventured to give an account of our progress in elucidating some points in the theory of the vacuum discharge, without any wish to ascribe to our results more weight than they deserve.

Batteries of this description may be had from Messrs. Tisley and Spiller, Brompton Road: their cost, in large numbers, is about one shilling per cell, exclusive of the charge of chloride of silver, which costs about two shillings per cell. The latter, either in the form of powder or of rods cast upon flattened silver wire, may be obtained from Messrs. Johnson and Matthey, Hatton Garden. When the battery is exhausted the reduced silver may be readily re-converted into chloride with scarcely any loss.

THE ROYAL INSTITUTION.

Notes of a Course of Seven Lectures on Electricity. By Professor Tyndall, LL.D., F.R.S.
February—March, 1875.

(Continued from page 99.)

Notes of Lecture V. *March* 4, 1875.

1. The Leyden jar is thus charged:—The outer coating being connected with the earth, and the inner coating with the electric machine, the electricity poured into the jar acts inductively across the glass upon the outer coating, attracting the opposite electricity, and repelling that of the same name to the earth. Two oppositely electrified layers are thus in presence of each other, being separated merely by the glass. On bringing the inner and outer coatings, by means of a discharger, near each other, before contact is established, discharge occurs in the form of a spark.

2. The escape of the repelled electricity from the outer coating of the jar may be shown by the gold-leaf electroscope, and by various other means.

3. Instead of allowing the repelled electricity of the outer coating to escape to the earth, it may be employed to charge a second jar, while the repelled electricity of this latter may be employed to charge a third jar, and so on. In fact, by insulating a system of jars, and connecting the outer coating of each with the inner coating of the next, the whole series may be charged by means of the electricity communicated to the first. This is Franklin's "Cascade battery."

4. Instead of glass we may employ any other insulator for the jar. Dry air may be employed. Two plates of brass—the one insulated, the other not, with a layer of air between them—constitute a virtual Leyden jar. The arrangement, however, has a name of its own—the "Condenser."

5. In charging the prime conductor of the electric machine the charge on the conductor continues to augment up to a certain point, after which it is not augmented by the further working of the machine. If the electricity be drawn away from the conductor, and stored up in a Leyden jar, it requires a greater amount of turning to reach the stationary point. This withdrawal, or, as it used to be considered, *condensation* of the electricity by the attraction of a layer of opposite electricity, is well shown by the condenser.

6. The condenser consists of two metal plates:—the one, called the collecting plate, insulated; the other, called the condensing plate, uninsulated. The nearer the two plates of the condenser are to each other, the more energetic is the "condensation;" and the thinner the glass of the Leyden jar, the more energetic is the condensation. The force of condensation in the Leyden jar was proved by Wilson and Cavendish to be nearly in the inverse ratio of the thickness of the glass.

7. The Leyden jar is sometimes perforated by the discharge of the electricity through the glass. A certain thickness of glass is necessary to prevent this.

8. The influence of the oppositely attractive coating may be well shown by laying a sheet of tinfoil on a table, a plate of glass on the sheet of tinfoil, and a second sheet of tinfoil upon the glass. All being loose, let the upper sheet of foil be connected with a gold-leaf electroscope, and with an electrical machine: turn the machine carefully till the leaves show signs of divergence; then lift the glass and upper coating by means of silk loops. Removed from the condensing action of the lower sheet of foil, the electricity of the upper one diffuses itself so strongly over the electroscope that, if care be not taken, the ruin of the instrument will be the consequence.

9. Sheets of common block-tin, or even sheets of ordinary foolscap paper unwarmed, may be employed in the last experiment, instead of the sheets of tinfoil.

10. With the principle of induction for our guide we can illustrate in various ways the action of the condenser and of the Leyden jar. Two metal plates, for example, with rounded edges, and with a sheet of vulcanised india-rubber between them, may be made to act as a very powerful Leyden jar.

11. In the first form of the Leyden jar the hand of the operator formed the outer coating, and the water the inner coating. But a complete jar may be formed by two hands, separated by an insulator. Standing, for example, on an insulating stool, with a sheet of vulcanised india-rubber covering my right hand, I clasp with it the left hand of my assistant, who stands on the ground. Laying my left hand upon the conductor of the active electrical machine, my right hand becomes the inner coating, and my assistant's left hand the outer coating, of a Leyden arrangement. On causing the two unclasped hands to touch each other, the "jar" is discharged, and a strong shock is experienced.

12. A spark may be obtained from the clasped hand-jar sufficient to ignite gas, or to fire powder.

13. The duration of the electric spark is very brief: in a special case Sir Charles Wheatstone found it to be 1-240000th of a second; this, however, was the maximum duration. In other cases it was less than the millionth of a second.

14. When a body is illuminated for an instant the image of the body remains upon the retina of the eye for a fraction of a second. If, then, a body in swift motion be illuminated by an instantaneous flash, it will be seen to stand motionless for the fraction of a second at the point where the flash falls upon it. A rifle bullet passing through the air and illuminated by an electric flash would be seen thus motionless; a circle divided into black and white sectors, and rotating so quickly as to cause the sectors to blend to a uniform grey, appears, when illuminated by the electric spark, perfectly motionless, with all its sectors revealed. A falling jet of water, which appears continuous, is resolved by the electric flash into its constituent drops.

15. Owing to its rapidity, the electric spark, in passing through loose gunpowder, fails to ignite the powder, but scatters it mechanically. By the introduction of an imperfect conductor—a wet string, for example—the discharge is retarded, and the powder fired. (The combustion of gun-cotton when detonated is, I am informed, so rapid that magnesium powder mixed with the cotton is unconsumed.)

16. Dry air is an insulator, which must be broken through to produce the electric spark. The comparative ease with which the discharge passes through a partial vacuum has been already, to some extent, illustrated. Through an exhausted glass tube, 6 feet long, a discharge freely passes which would be incompetent to leap over a minute fraction of this interval in air. But whereas the spark in air

is dense and brilliant, the discharge *in vacuo* fills the exhausted tube with a diffuse light.

17. Priestley thus describes the light *in vacuo*:—"Take a tall receiver, very dry, and in the top of it insert with cement a wire not very acutely pointed; then exhaust the receiver, and present the knob of the wire to the conductor, and every spark will pass through the vacuum in a broad stream of light, visible through the whole length of the receiver, be it ever so tall. This stream often divides itself into a variety of beautiful rivulets, which are continually changing their course, uniting and dividing again in the most pleasing manner. If a jar be discharged through this vacuum it gives the appearance of a very dense body of fire, darting directly through the centre of the vacuum without ever touching the sides."

18. Cavendish employed a double barometer-tube, bent into the form of a horse-shoe, with its curved portion empty, to show the passage of electricity through a vacuum. But it is really not the vacuum which conducts the electricity, but the attenuated air and vapour which fill the space above the barometric columns. When the mercury employed is carefully purged of air and moisture by previous boiling, the space above the mercury—as proved by Walsh, De Luc, Morgan, and Davy—is wholly incapable of conducting electricity. I have seen a similar experiment in the laboratory of Mr. Gassiot, to whom we are indebted for so many beautiful electrical experiments.

19. Electricity therefore does not pass through a true vacuum; it requires ponderable matter to carry it. If, moreover, a gold-leaf electroscope be kept at a distance from all conductors, it may be kept charged for an almost indefinite period in a good air-pump vacuum.

20. The matter rendered thus luminous by the electrical discharge is attracted and repelled like other electrified matter. "A finger," says Priestley, "put on the outside of the glass will draw it [the luminous stream] wherever a person pleases. If the vessel be grasped with both hands, every spark is felt like the pulsation of a great artery, and all the fire makes towards the hands. This pulsation is felt at some distance from the receiver; and in the dark a light is seen betwixt the hands and glass."

21. "All this," continues the historian of Electricity, "while the pointed wire is supposed to be electrified positively; if it be electrified negatively the appearance is remarkably different. Instead of streams of fire nothing is seen but one uniform luminous appearance, like a white cloud, or the milky-way on a clear starlight night. It seldom reaches the whole length of the vessel, but is generally only like a lucid ball at the end of the wire.

22. Of the two appearances here described, the former is now known as the *electric brush*, and the latter as the *electric glow*. Both can be produced in air. The glow is sometimes seen on the masts of ships, and it is mentioned by the ancients as appearing on the points of lances. It is called St. Ermo's or St. Elmo's fire, after the sailor's saint, Erasmus, who suffered martyrdom at Gaeta at the beginning of the fourth century.

23. The colour of the diffused light referred to in Note 16 depends upon the residue of attenuated gas, or vapour, through which the discharge passes. If it be an oxygen residue the light is whitish; if it be a hydrogen residue the light is red; if a nitrogen residue the light is purple, exactly resembling the colour displayed at times by the aurora borealis—a colour doubtless due to the discharge of electricity through the attenuated nitrogen of the air.

24. When this electric light is subjected to prismatic analysis it is found to produce, not a continuous spectrum, with the seven colours gradually passing into each other, but a series of separate and distinct bands. At an early period such bands were noticed in the spectrum of the electric spark. They are, for the most part, due to the vapour of the metals between which the spark passes. The spectrum of the electric discharge is often of a very complex character, being in part due to the gas through which the discharge passes, and in part to the incandescent vapour of the electrodes.

25. This vapour and the particles of the electrodes enable an ordinary voltaic current to cross a space which it is quite incompetent to cross when occupied by air.

26. The spectrum bands of incandescent vapours, which are perfectly constant, furnish by their constancy a means of analysis by the prism. Hence has resulted that powerful and far-reaching mode of inquiry called spectrum analysis, which has led to the discovery of new metals, to a secure knowledge of the constitution of the sun and his appendages, and of the nebulæ, comets, and fixed stars.

27. The electric spark produced within a ball of ivory, an orange, or an apple, illuminates the body throughout. Eggs through which the discharge of the Leyden jar is passed are similarly illuminated.

Experiments in Lecture V.

(1.) Leyden jar placed on table; outer coating connected with electroscope: no divergence of leaves when electricity is communicated to the knob.

(2.) Jar placed on india-rubber cloth, with outer coating connected with electroscope: leaves diverge when electricity is communicated to knob. The electricity of the outer coating was here prevented from flowing to the earth, and flowed over the gold leaves. Detach wire, and prove electricity positive.

(3.) Taking oldest form of Leyden jar, with its nail and water, in the left hand: standing on insulating stool, and stretching a lath from the right hand to the electroscope: on electrifying the nail, the gold leaves diverge. As before, the electricity proves positive.

Remark:—A rubbed glass tube amply suffices to communicate to the jar the small charge needed for these experiments.

(4.) The action of Franklin's "cascade battery" referred to in Note 3 was illustrated.

(5.) Bringing the two plates of a condenser close together, but not into contact, and charging gently the insulated plate, which is connected with the electroscope, the leaves diverge slightly. On withdrawing the condensing plate they fly asunder: they fall again when condensing plate is brought near. Divergence and collapse always follow withdrawal and approach of condensing plate.

(6.) Notes 8 and 9 were illustrated. Block tin is very convenient. A plate of glass or a piece of

india-rubber cloth may be used as the insulator. For the block tin, moreover, sheets of common foolscap may be employed. In the actual experiment, the table was covered with paper: a piece of vulcanised rubber, or of glass, was laid on the table, and on it a leaf of foolscap, which was connected by a wire with the electroscope. On electrifying the foolscap, and alternately lifting it and lowering the glass or india-rubber, effects quite as instructive as those produced by the condenser were obtained.

(7.) Charged with the electrical machine instead of the glass tube powerful sparks passed from plate to plate in the experiment referred to in Note 10.

(8.) The action of the Leyden jar formed of the clasped hands referred to in Note 11 was illustrated. A brass rod with a small ball at the end was used to ignite the gas from an Argand burner. The shock at the same time was very smart.

(9.) A circuit was formed between the prime conductor of the machine and the earth, a Leyden jar being included in the circuit. At one place (the focus of a small reflector) the circuit was interrupted, and immediately in front of this focus was the rotating disc referred to in Note 14. On working the machine the jar was periodically discharged; and at every spark the rotating disc appeared for a moment motionless, with all its sectors visible.

(10.) Note 15 was illustrated.

(11.) Note 17 was illustrated.

(12.) The double barometer-tube being connected on the one side with the conductor and on the other with the earth, a feeble gleam of light appeared in the bent portion of the tube when the machine was worked. On introducing a space into the circuit, over which the electricity leaped in a spark, a vivid bow of light, which increased in brilliancy as the spark was lengthened, filled the tube.

(To be continued.)

ON THE FORMS OF EQUIPOTENTIAL CURVES AND SURFACES AND LINES OF ELECTRIC FORCE.*

By W. GRYLLS ADAMS, M.A.,
Professor of Natural Philosophy and Astronomy in King's College, London.

"THE paper contains an account of certain experimental verifications of the laws of electrical distribution in space and in a plane conducting sheet."

The potential at any point of an unlimited plane sheet due to a charge of electricity at any other point of the plane at distance r from it is proportional to the logarithm of the distance, and the potential due to two or more charges at different points of the plane is the sum of the potentials due to the several charges, so that when there are two points in a plane conducting sheet connected with the poles of a battery, as there are equal currents flowing at those two points, one into and the other out of the sheet, the potential at any point of the sheet is proportional to the difference of the logarithms of its distances from the two points or electrodes where the current enters and leaves the sheet.

The potential is constant for a series of points if the difference of the logarithms of the distances of each of those points from the electrodes remains constant, *i.e.*, if the ratio of the distances of each of those points from the electrodes remains constant.

The curve joining this series of points is an equipotential curve.

If r and r_1 are the distances of any point in the curve from the two electrodes, and c a constant then—

$$r = cr_1.$$

Hence the equipotential curves are circles with their centres on the line joining the two electrodes; and the lines of force which cut the equipotential curves at right angles are also arcs of circles passing through the two electrodes.

The lines of force may be regarded as distinct from one another, but as filling up all the space on the conductor between the two electrodes; and the distribution would not be altered if we conceive of them as divided from one another like separate wires conducting currents side by side. By taking out any space bounded by lines of force, we shall increase the quantity flowing along the other lines of force, but shall not alter the distribution of the current among them. Hence we may cut out a disc from an unlimited sheet without altering the form of the lines of force, if the boundary of the disc be arcs of circles passing through the two electrodes, so that for a circular disc with the electrodes on the edge of it, the equipotential curves are circles having their centres on the straight line joining the electrodes.

The forms of the equipotential curves may be traced out experimentally by attaching two battery electrodes to a disc of tinfoil, and having two similar electrodes attached to a delicate galvanometer; one of these electrodes being fixed at a point through which the equipotential curve is to be drawn, the other may be moved from point to point to trace out the successive points, so that no current may pass through the galvanometer. A comparison of the experimental results with the theory shows a complete agreement.

In a large square sheet 310 m.m. in diameter, with the electrodes 126 m.m. apart, the curves in the centre and near the electrodes, which are drawn by pricking fine holes through the tinfoil on a sheet of paper below, are very accurately circular, and mostly coincide with circles until the points are so far from the centre that the form of the equipotential curves is affected by the edge of the disc. In a circular disc with the electrodes on the edge subtending 60° at the centre, the experimental curves are shown to be accurately arcs of circles with their centres on the line joining the electrodes.

In an unlimited sheet, when there are several electrodes by which currents enter and leave the sheet, the potential at any point is—

$$\mathrm{A} \log \left(\frac{r\ r'\ r'' \ldots}{r_1 r_1' r_1'' \ldots} \right),$$

where $r, r', r'' \ldots$ are the distances to the electrodes of one kind, and r_1, r_1', r_1'' are the distances to the electrodes of the other kind. Taking the case of one positive electrode at the centre and four

* Abstract of a Paper read before the Royal Society.

negative electrodes round it at the corners of a square, the curves are traced and are seen to be the same as the curves at the corner of a square sheet, with a positive electrode at the corner and two negative electrodes on the edges; the curves are also the same for a square sheet with a positive electrode at the corner, and one negative electrode along the diagonal.

The equation for these equipotential curves is—

$$r^4 = cr_1r_2r_3r_4,$$

and is derived in the case of the limited sheets by considering that to every electrode on the limited sheet there corresponds an equal and like electrode at each of the electrical images of that electrode formed by the edges of the sheet. If we trace the curves for this arrangement of electrodes in the unlimited sheet, the edges of the limited sheet will be some of the lines of force, and so we may divide the sheet along these edges without altering the form of the equipotential curves. Where an electrode and its images coincide in position, the index of r is equal to one more than the number of images.

When there are four electrodes, two of each kind on an unlimited sheet, an equipotential curve is given by the equation—

$$rr' = cr_1r_1'.$$

If the four points lie on a circle, and the complete quadrilateral be drawn through them, the circles which have their centres at the intersections of opposite sides of the quadrilateral, and which cut the first circle at right angles, will also cut one another at right angles. One of these circles is shown to be an equipotential curve for the four electrodes, and the other is a line of force.

Hence, if we cut the unlimited sheet along the edge of this latter circle, we shall not alter the forms of the equipotential curves; and within it we shall have one electrode of each kind, the others being their electric images, the product of the distances of an electrode and its image from the centre being equal to the square of the radius of the disc. If an electrode is at the edge of the disc, then the electrode and its image coincides, and the equation to the equipotential curve is—

$$r^2 = cr_1r_2.$$

When one pole is at the edge and the other is at the centre of a circular disc, since the electric image of the centre is at an infinite distance, the equation to the equipotential curves is—

$$r^2 = cr_1.$$

This is an interesting case, as showing that the equipotential curves do not always cut the edge of the disc at right angles. The curves around the centre of the disc are nearly ellipses of small eccentricity, with one focus in the centre; but on placing one tracing electrode at a distance from the centre—

$$= (3 - 2\sqrt{2})a,$$

between the electrodes, where a is the radius, there is great uncertainty in determining the form of the curve on the opposite side of the centre of the disc.

This is explained by the fact that the electrodes were 1 m.m. in diameter, and a difference of distance of 1 m.m. between the electrodes near this point corresponds to a large portion of the disc on the other side of the centre; this portion including an area of about 500 square millims. in a circle 36 millims. in radius, *i.e.* about one-eighth of the whole area of the circle. On placing one of the galvanometer-electrodes at the extremity of the diameter through the battery electrodes, and tracing with the other, it is found that the equipotential curve through that point cuts the edge of the disk at an angle of 45°, and that there are two branches cutting one another at right angles.

These peculiarities are explained on tracing the curve—

$$r^2 = 4ar_1$$

corresponding to this case. The extremity of the diameter is a point through which two branches of the curve pass at right angles to one another.

The forms of the equipotential surfaces and lines of force in space may be determined experimentally by taking a large vessel containing a conducting liquid and placing two points, the ends of two covered wires, for battery electrodes at a given depth in the liquid and away from the sides and ends of the vessel, taking similar covered wires immersed to the same depth for galvanometer-electrodes.

For two electrodes the equipotential surfaces will be surfaces of revolution around the straight line joining them, and so will cut any plane drawn through this straight line or axis everywhere at right angles.

Hence we may suppose sections of the liquid made along such planes without altering the forms of the equipotential surfaces. This shows that we may place our battery electrodes at the side of a rectangular box containing the liquid, and with the points only just immersed below the surface of the liquid, and the equipotential surfaces will be the same as if the liquid were of unlimited extent in every direction about the electrodes.

We shall obtain the section of the equipotential surface by taking for galvanometer-electrodes two points in the surface of the liquid, keeping one fixed and tracing out points of equal potential with the other.

The potential at any point in space, due to two equal and opposite electrodes, is—

$$A\left(\frac{1}{r} - \frac{1}{r_1}\right),$$

where r and r_1 are the distances of the point from the electrodes, so that for an equipotential surface—

$$\frac{1}{r} - \frac{1}{r_1} = \text{constant}.$$

These surfaces are cut at right angles by the curves $\cos.\theta - \cos.\phi = c$, which are also the magnetic lines of force, θ and ϕ being the angles which the distances from the electrodes make with the axis. That the lines of force in a vessel of finite size should agree with the lines of force in space, the form of the boundary of the vessel in a plane through the axis should everywhere be a line of force; but the ends of a rectangular vessel coincide very closely with certain lines of force, either when the electrodes are at the ends, or when there are two electrodes within the vessel, and two supposed electrodes at their electrical images at an equal distance outside the ends of the vessel.

The equipotential surfaces are given in this case by the equation—

$$\frac{1}{r}+\frac{1}{r'}-\frac{1}{r_1}-\frac{1}{r'_1}=\text{constant},$$

and the lines of force by the equation—

$$\cos.\,\theta+\cos.\,\theta_1-\cos.\,\phi-\cos.\,\phi_1=c.$$

The curve, for which $c=2$, coincides very closely with the ends of the box.

The equipotential surfaces were traced out in sulphate of copper and in sulphate of zinc by the following method:—

A rectangular box was taken, and the battery electrodes attached to pieces of wood which could be clamped at the centre of the end of the box, and could be brought to any required point in the line joining the middle points of the end of the box. The galvanometer-electrodes were attached to T-pieces which rest on the ends and sides of the box, and the position of the electrodes read off by millimetre-scale placed on the ends and sides of the box.

In the sulphate of copper experiments covered wire with the end exposed was immersed to half the depth of the liquid; in the experiments with sulphate of zinc the zinc electrodes were just immersed below the surface of the liquid. The close coincidence between the experimental curves traced out, and the theoretical curves and surfaces in space is shown by a comparison of the numbers given in the paper for several of the curves which have been traced out; it also shows that, by reversing currents alternately, it is very easy to keep the polarisation very small and of constant amount on the galvanometer electrodes.

When the electrodes are parallel lines extending throughout the depth of the liquid the equipotential surfaces are cylindrical, and their sections are given by the equation—

$$\text{log. } (rr'\ldots)-\text{log. } (r_1r_1'\ldots)=\text{log. } c,$$

where there are several positive and several negative electrodes, $r\,.\,r'\ldots$, &c., being measured from the points where the electrodes cut the plane of the section.

Hence the forms of these equipotential curves are the same as in a plane sheet, so that the forms traced out in tinfoil will be the same as the corresponding forms in space for line electrodes. These forms may be traced out in sulphate of copper with copper electrodes, or in sulphate of zinc with amalgamated zinc electrodes, and for these experiments with cylindrical and other vessels, the polar coordinates may be measured directly. One of the battery electrodes is mades the origin of coordinates, and a lath or brass wire resting on the edges of the vessel has a slot along it, the origin being at one end of or at some point of the slot. In the slot is a sliding piece of wood or ivory which carries one of the galvanometer-electrodes, and the lath is capable of turning about the battery electrode on which it is placed. Around this electrode is a graduated circle for measuring the angles about the origin, and on the sides of the slot is a millimetre-scale for measuring the distances from the origin.

The other galvanometer-electrode may be fixed in a manner which is most suitable in each case.

The result of these investigations show how closely the experimental determination of equipotential surfaces and lines of force agrees with the theory of electrical distribution in space.

OPEN AND CLOSED CIRCUITS.

The following reply to "Inquirer" has appeared in a recent number of the New York *Journal of the Telegraph*:—

"The writer asks, in reference to certain statements, and citing the English preference of the open and the American for closed circuits, Which is correct? We answer—Both, but with the advantage apparently in favour of the American system. It is undoubtedly true that osmotic action and exosmotic action, which really mean the same thing, are aided by the current. It is equally true that with a closed circuit the action of the zinc element is in excess of the copper element, the exosmosis of which it holds in check. It is also true that an open circuit, too long continued, leads to such a deposit of copper on the zinc as to reduce action of the latter, and consequent waste of material and decrease of power. Thus both the open and the closed circuits have their losses and values. The problem, after all, is what amount of alternately open and closed circuits contribute most to the preservation of constancy, and economic and equal action of the battery elements. We do not believe that there is a margin of advantage in either case, so far as constancy is concerned, from which to prove very marked superiority, yet it would be a useful subject of investigation to determine the actual rates of consumption under the two systems. The apparent advantage of the American plan is in the fact that main batteries are only needed at terminal offices, while the open circuit system requires them at all stations."

With further reference to the subject, we believe that one great argument against the use of the "closed circuit" principle is that it rapidly destroys under-ground work. In America—where the use of covered work is very limited—this objection does not exist; but in England—where every large town has an extensive mileage of underground work—the destruction of the gutta-percha insulator would be a serious matter.

To us it appears that the great advantage of a "closed circuit" lies in the fact that it—in consequence of the battery power remaining fairly equal throughout, and the current fairly constant at each station whichever station on a crowded circuit is working—obviates all that troublesome adjustment necessary where the "open circuit" principle is in force, when the circuit has upon it more than two offices. Whether, however, this is compensated by the evident influence the constant current exercises upon the gutta-percha under-ground work is a question for consideration, and no doubt it is one which will have to be governed very much by local circumstances.

Post-Office Telegraphs.—Statement showing the total number of messages forwarded from Postal Telegraph Stations in the United Kingdom during the week ended the 15th May, 1875, and during the corresponding week of 1874:—1875, 406,574; 1874, 375,524; increase in the week of 1875 on that of 1874, 31,050.—Week ended 22nd May, 1875, and corresponding week of 1874:—1875, 386,773; 1874, 365,452; increase in the week of 1875 on that of 1874, 21,321.

Notes.

It appears that in the Arctic Expedition "Electricity" will not be forgotten, for experiments are to be made with regard to the electrical state of the atmosphere. Sir William Thomson supplies his well-known portable "electrometer," and other instruments will be used. Spectroscopes are provided for observation of the aurora; and the employment of batteries for obtaining comparison spectra being out of the question, a Gramme machine has been provided to produce the necessary current of electricity.

The Post-Office Submarine Telegraph stores, at Lowestoft, were destroyed by fire on the eve of the Derby. The flames spread with great rapidity, and the building—which was 300 feet in length—was destroyed, together with a quantity of paraffin, paint, and other oils, and a number of rockets. The total damage caused by the fire is estimated at £18,000, including a quantity of submarine cable. The contents, to the extent of £14,000, were insured in the Sun Office.

The manufacture of the new cable for the Western Union Telegraph Company, from Punta Rana to Key West, is being carried on at the India-rubber Company's Works, at Silvertown.

The Anglo-American Telegraph Company have introduced a word-tariff since May 1st, and, though the effect of the reduction has not yet proved successful, there can be no doubt that it is a step in the right direction. The price varies from 1s. 6d. to Newfoundland to 3s. 6d. to Vancouver Island. It is 2s. to New York, 2s. 6d. to California, per word.

The fifth International Telegraph Conference, which is on this occasion to be held at St. Petersburg, assembles on the 1st inst. Representatives from all countries and foreign telegraphic administrations will be present, the British Postal Telegraph Department being represented by Mr. H. C. Fischer, the Controller of the Central Telegraph Station in London, and Mr. Alan E. Chambre, the Surveyor of the Private Wire Branch of the Department. Colonel Robinson with Major Bateman represent the Indian Telegraph Department; Sir James Anderson and Mr. Lewis Wells (formerly of the Electric and International Telegraph Company) the Eastern Telegraph Company; Sir James Carmichael and Mr. S. M. Clare the Submarine Company; Mr. Andrews the Indo-European Company; and Mr. H. G. Erichsen the Great Northern Company. The principal business of the Conference will be the codification of regulations arrived at on previous meetings, so as to secure some uniformity in the treatment of international telegrams. An important proposition, having for its object the reduction of the *minimum* number of words in foreign-European messages from 20 to 10, and a corresponding reduction of the tariff for such messages, will be brought forward; and the attention of the Conference will be asked to a somewhat similar proposition with regard to extra-European messages. The sittings of the Conference will, it is anticipated, extend over a period of six weeks.

The annual general meeting of the Great Northern Telegraph Company took place at Copenhagen on the 28th of April. Count Sponneck presided. During the past year no extensions of the European cables have been made, efforts having been confined to thoroughly consolidating the undertaking, and otherwise utilising the resources at the Company's disposal. Two cables had been broken, one of which (France and Denmark) had only recently been repaired. All cables were now in a most satisfactory state. The Danish Government lines had been improved and rebuilt. Sir William Thomson's recorder was the instrument now employed on all lines between England, Denmark, and Russia, and the speed had thereby been considerably increased. The European traffic statistics show an increase of 27 per cent on the 1873 work, viz.:—

	Francs.
1874.—722,386 messages, value	2,332,568
1873.—536,206 „ „	1,840,496
Increase	492,072

A school for theoretical and practical education had been established at Taborg, near Copenhagen, and a pension fund for the Staff of the Company started. It now counted 150 members, who contribute 3 per cent of their salaries, and the Company a like amount. Interruptions to the China and Japan cables had been few compared to the previous year. The land lines were in good condition, and extensions in China were being cultivated. The increase of traffic over this section of the Company's system, as compared with 1873, equalled 38 per cent. The dividend for the year was fixed at 7 per cent, Mr. O. B. Suhr being re-elected as a Director, and Admiral Bille and Mr. Berner as Auditors.

From the Annual Report of the Atlantic and Pacific Telegraph Company we learn that its system now covers, 14,612 miles of poles, and 28,477 miles of wire, serving 1385 offices. During the year new lines had been constructed to the extent of 728½ miles. The gross receipts were 450,534·01 dols., and the gross expenses 399,111·97 dols., leaving a net profit of 51,422·04 dols. Exclusive

use of Sir Charles Wheatstone's automatic system of transmission in the United States and the Island of Cuba had been purchased, and important extensions—by which the Company's system will embrace all the leading cities north and south—are under consideration, with the prospect of favourable results. The reduced rates, which took effect on the 15th of February, resulted in an immediate increase of business quite equal to the Company's expectations. Further reductions are contemplated as soon as the increase of wires and manufacture of automatic apparatus will admit of a proper discharge of the contemplated increase.

The *Journal of the Telegraph* publishes, as an extract from the *Albany Evening Journal*, a description of an iron telegraph-pole which is now being manufactured for use in New York. It is stated to be lighter than a wooden pole of the same height, far stronger, and capable of supporting a much greater weight. Its construction is that of a number of wrought-iron bars, rolled out the entire length of the pole, which bars are placed around light cast-iron cores, arranged at proper intervals from each other. The cores have seats or notches to hold the bars in their places, so as to prevent their moving sideways, and the bars also have notches into which the cores fit, to keep them from moving up or down. Around the outside, where each core is placed, a ring or band of wrought-iron is tightly fitted, which holds the bars firmly in their places. Any number or any sized bars may be used, but it is found that six very light bars of angle iron arranged in this way afford a strength equal to that required for a pole 50 feet in height. The cores are larger at the base than at the top. No machinery or shop labour is required to put it together other than the making of the outside rings, so that a pole may be ordered in pieces and put together at the point where it is to be used.

A Bill introduced into the New York State Assembly, to compel telegraph companies to put their wires underground in the cities of New York and Brooklyn, has been thrown out by the Committee on Cities and Villages, to which it was referred. The Committee, after repeated hearings, by a unanimous vote decided not to report it.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

At the ordinary meeting on Wednesday, 10th March, Mr. Latimer Clark, President, in the chair,

The paper read was "*On Batteries and their Employment in Telegraphy*," by James Sivewright, M.A., Associate. After stating that it was not his intention to enter into the history of the battery, the author proceeded to a brief review of the rival contact and chemical theories which had been advanced to account for the action observed in the galvanic or voltaic cell.

Having shown that the former was in direct opposition to the principle of the conservation of energy, and that the more delicate testing apparatus invented since Faraday's time had demonstrated the latter to be untenable, he explained the latest theory which had been put forward. This reconciles to some extent the previous theories, for it allows on the one hand, to the supporters of the contact theory, that the initial action is due to the simple contact of dissimilar bodies, whilst on the other hand it asserts that this action can be maintained only by chemism. The weak point of this, however, as well as of the old contact theory, was stated to be the difficulty in accounting for the initial action. For, recognising the universal truth of the principle of the conservation of energy, that it is an absolute impossibility to create force *de novo* without the transmutation of an equivalent from some other form, it is difficult to see how the simple contact of two dissimilar bodies can of itself call into play any novel form of energy. Experiment, too, it would seem, can bring but little assistance to a satisfactory solution of the difficulty, that so far as one can judge at present must be left to the scientific imagination.

Having pointed out the deleterious effects of *galvanic polarisation* and *local action*, to one or other of which all batteries are more or less subject, the author proceeds to state the conditions which, in his opinion, should be fulfilled by a perfect battery for actual every-day use. They are three in number, and are as follows:—

(1.) That the current obtained from it should be constant.

(2.) When the battery is not actually required, there should be no action going on in it attended by a needless consumption material.

(3.) The materials employed in its construction and maintenance should not be expensive, or, at all events, should be as inexpensive as possible, and there should be no difficulty or danger in handling them.

The Daniell is selected as the first battery for examination, not more on account of the time-honoured position which it occupies, than from the fact that in one or other of its numerous modifications it is more widely employed than any other.

After describing the principle of Daniell's battery, and the mechanism of the "ordinary" form which is in general use in England, the author observed that this battery fulfilled more than any other, the first condition, viz., that of constancy; but that as regards the second, it fell far short of the ideal battery. Unnecessary waste of materials is constantly going on in it by reason of "osmose" and the diffusion of the two liquids—solutions of copper sulphate and zinc sulphate—which are employed, and the amount of real work done is thus out of all proportion to the materials consumed. With the object of surmounting this evil, which is inherent in all forms of two fluid batteries, M. Leclanché introduced the battery which bears his name. This, although admitted to be superior to all the single fluid batteries hitherto tried, was stated to labour under some, at least, of the disadvantages to which they are subject. Constancy is not to be found in the battery when it is incessantly worked for any length of time: the variation in the strength of current is attributed—first, to the unconsumed hydrogen accumulating in the negative element, and the giving rise to galvanic polarisation; secondly, to the formation of double salts—oxychlorides and zinc ammonic chlorides—which

being slowly soluble, interpose additional internal resistance in the path of the current.

Although inferior to Daniell's battery in the matter of constancy, the Leclanché possesses a decided advantage over any other battery which has hitherto been tried so far as the second condition is concerned. No unnecessary waste can take place from either osmose or diffusion. The defects when the battery was at rest lay in the corrosive action which takes place at the point where the connecting wire is united to the negative element; the destruction of the connecting wire by the fumes of free ammonia given off in the action of the battery, and the formation of white-lead. The first two, it was pointed out, had been got rid of to a great extent by the introduction of the trough form of Leclanché, but the last-named had not thus far been eradicated. Still the main difficulty and the chief item of expense in the maintenance of this battery, it was urged, is the porous pot or partition. Whether in the earlier or later form these crack or flake, owing to the formation of the double salts, whose influence as they pass from a state of solution into the solid form cannot be resisted. This and the galvanic polarisation disqualify Leclanché's battery from being used where a heavy strain is to be placed upon it: it is thus unsuited for a "local," and cannot be relied upon for the maintenance of a constant current.

To obviate the necessity of having a porous partition at all in Daniell's battery, the "gravity" form of battery was introduced: in this the liquids are kept apart by the force of gravity alone. The Minotto, one of the best known of the class, is universally employed in India, as well as for some special purposes in England, and has given universal satisfaction.

Grove's battery, it is stated, possesses none of the qualifications which a battery intended for general use in telegraphy should possess. The current obtained from it is not constant for any length of time: there is a vigorous chemical action attended with unnecessary waste going on even when the battery is at rest, and the materials employed in it are both expensive and difficult to handle. Notwithstanding all this, Grove's battery was largely employed until quite recently in America. So also was the carbon or electropoion battery, which differed from the Grove in having a plate of carbon immersed in a solution of bichromate of potash as the negative element in place of a plate of platinum in concentrated nitric acid. Both of them are now fast disappearing in favour of one of the numerous forms of gravity battery, the Callaud, the Hill, the Lockwood, the Baltimore.

The Callaud, which is a gravity battery pure and simple, is that which is coming into most extensive use in America. Complete rest, so as to prevent the mixture of the two liquids, is essential in it as in all similar forms of gravity batteries for efficient working. When this is ensured, the Callaud appears to do satisfactorily what is required of it.

The special feature of the Lockwood is the arrangement of the negative element. It consists of two concentric coils of coppered wire, and an upright standard formed of a straight piece of heavy copper wire provided with nuts and washers at each end. These coils are wound in reverse directions, and "the influence of the electric current passing through the coils when the battery is at work, is such as to keep the two solutions apart," according to the statement made by the proprietors of the battery. Whether there is any special virtue or not in this arrangement of the copper plate, the author was not at present prepared to say.

After a brief allusion to the Baltimore battery, and the form manufactured by Messrs. Siemens and Halske, the author concluded by saying that the perfect battery for universal use—if anything in connection with telegraphy will ever be accounted perfect—is still a thing of the future, and must, when it eventually does make its appearance, realise on the one hand the principle aimed at by Leclanché of giving in the work done a complete equivalent for the materials consumed, and inspire on the other hand the perfect confidence of the Daniell in being equal to any emergency, and ever ready to respond to whatever demands are made upon it.

The discussion on this interesting paper was adjourned, and resumed on the 24th March; it again occupied the whole attention of the meetings on the 14th and 28th April, when it was finally brought to a close. The paper and discussion certainly form the most important of any yet brought before the Society, and regret is felt that space cannot be given to a full report of the discussion. The paper was commented upon by several well-known gentlemen. Mr. C. V. Walker entered carefully into the relative cost of graphite and other batteries. Mr. Hawkins gave interesting details of the Leclanché battery. Mr. Alfred Bennett read some interesting statements relative to numerous experiments with regard to new forms of batteries. Dr. John Hall Gladstone spoke at some length upon the general question; whilst Mr. E. Graves gave expression of sundry practical results obtained in the Post Office. Mr. Higgins dealt with batteries for requirements of large quantity, and explained those used by the Exchange Company; he also explained and showed in action the "Clamond Thermo-Electric pile" (of which we shall give our readers a separate description). Mr. Alfred Smee, F.R.S., gave interesting particulars of the well-known platinum-zinc battery. Dr. Siemens furnished further communication. Mr. Preece entered into minute detail of the theory and action of such forms of batteries as are in use by the Government, and drew especial attention to the difficult nature of electrical nomenclature as at present adopted. Mr. Warren De la Rue showed his chloride of silver battery of 1000 elements, and with the aid of condensers and vacuum tubes exhibited various experiments on the stratification of light. The discussion, after a reply from the author, was brought to a close with some able remarks from the President.

METEOROLOGICAL SOCIETY.

At the last meeting of the Meteorological Society, on Wednesday evening, May 19th, a paper was read by the President, Dr. MANN, "*On some Practical Points Connected with the Construction of Lightning Conductors.*" The paper dealt especially with the material and dimensions of conductors, the nature and influence of points, the essentials of earth-contacts, connection with metallic masses forming a part of the construction of buildings, the power of induction in producing return shocks, the dangerous action of metal chimney pots upon unprotected chimney shafts, and the facility with which houses may be efficiently protected when the defence is made part of the original design of the architect. The conditions which were finally insisted upon as indispensable to efficiency of protection were—1. Ample dimension and unbroken continuity in the lightning rod. 2. Large and free earth contacts, with frequent examination by galvanometers if the condition of these so prove that they are not in process of impairment through the operation of chemical erosion. 3. The employment of sufficient points above to dominate all parts of the building. 4. The addition of terminal points to the conducting cistern wherever any part of the structure of the building comes near to the limiting surface of a conical space having the main point of the conductor for its height, and a

breadth equal to twice the height of that point from the earth for the diameter of its base. 5. The avoidance of all less elevated conducting divergencies within striking distance of the conductor, and especially of such dangerous divergencies of this character as gas-pipes connected with the general mains, and therefore forming good earth-contacts.

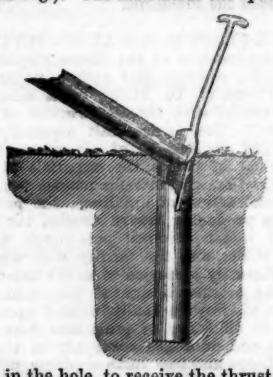
Correspondence.

EARTH-BORING FOR TELEGRAPH POLES.

To the Editor of the Telegraphic Journal.

SIR,—Reading in the TELEGRAPHIC JOURNAL of the 1st of January a discussion on the merits of post-hole borers, and having had some experience in the construction of telegraph lines in South America,—moreover as my experience is totally at variance with Mr. Burton's and Mr. Truenfeld's,—I hasten to give it to you. I agree perfectly with Mr. Gavey in the advantages of the borer. I have used the ordinary American borer, and consider it an indispensable tool in telegraph construction in this country. In the province of Buenos Ayres, where there is neither gravel nor stone of any kind (except at a few isolated spots in Tandil, in the far south, where telegraphs or railways have not yet reached), the borer can be used with great advantage. In Entre Rios and Corrientes you find gravel-hills, and loose stone occasionally, and have to use a chisel-bar to loosen it; but there are places all over the country where it would be impossible to secure a pole firmly without a borer—in Banados, or low swampy places. As to the men objecting to carry extra tools, those who have once used the borer eagerly ask for it again; besides, the man who carries the borer carries nothing else, his companion carrying spade and bar if required—pick and shovel are never used.

I have had no difficulty in boring holes making an angle of 60° with the surface, on railway curves where the poles require to be canted, nor have I seen any poles so crooked that I could not fix them with the borer. As for the earth being pushed down into the hole in erecting the pole, any intelligent workman can prevent that with the rounded spades used in this country (see Fig.). One man holds the spade with the



blade half in the hole, to receive the thrust of butt of pole and prevent it running into the earth while the others are lifting it. As Mr. Gavey remarks,—"The smallness of the space between pole and ground is one of the great advantages of a bored hole," particularly in wet soil, where, if the hole is dug with spade and shovel, no amount of ramming will secure a pole without stones, which may not be at hand: with a bored hole any flat stick or batten will do to ram the small space between pole and ground, and poles put up in bored holes I have found firmer than any others. In case a pole is heavier than usual it is only necessary to scoop away a little earth from edge of hole, as shown by dotted lines in sketch.

In a line 155 kilometres in length, passing through a country diversified with gravel-hills, swamp, soft loam, tough clay, and sandy soil, and put up by two gangs of fourteen and sixteen men respectively, the smaller gang had two borers between them; the larger gang, for want of borers, used the rounded spade, a bar, and scoop. The following is the proportion of work done by each gang:—

Small gang, with borers.. .. 13 parts
Large gang, with spades .. 7 ,,

The small gang used scoop, spade, and bar, as well as large gang in the hard ground.—I am, &c.,

J. H. BLOOMFIELD,
East Argentine Railway.

Concordia, Entre Rios, Republica Argentina,
March 25, 1875.

Electrical Science in English and Foreign Journals.

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxx., No. 15. April 19, 1875.

The Theory of the Process of Magnetisation.—J. M. Gaugain.—This is so bound up with other papers, from the same author, on the subject of magnetism, that we have not room to spare in our columns to intelligibly abstract it. We therefore refer our readers to the original paper.

A New Source of Magnetism.—Donato Tommasi.—When a current of steam, subject to a pressure of 5 to 6 atmospheres, is passed through a copper tube measuring 2 to 3 m.m. in diameter, and covered with a helix around an iron cylinder, the cylinder becomes magnetised so that an iron needle situated some centimetres distant from the *vapour magnet* is energetically attracted, and remains magnetised during the whole time of the steam-current's passage through the copper tube.

Bulletino Telegrafico. Anno xi. March, 1875.

An agreement has been entered into with the "Erlanger" Company to lay and maintain a submarine cable from the Italian mainland to the island of Sardinia.

The *Perseveranza* gives a description of the monument erected, at Camnago, in honour of Volta.

Volpicelli read a paper before the Accademia dei Lincei, on the 14th of February, on Melloni's theory of electrostatic induction, which, he argued, was preferable to that commonly adopted.

A new International Telegraphic Conference will be opened at St. Petersburg in the course of June. The proposal for the neutralisation of telegraphic lines will be abandoned, since the great powers are not disposed to give it their adhesion.

New Use of Platinum.—*La Revue Britannique* announces that George Robinson, of New York, has invented a new process for sawing all woods with the greatest ease. Instead of a saw he uses a thin platinum wire, heated to whiteness by the continuous passage of an electric current.

To Correspondents.

G. E. S.—We shall be happy to insert a scientific explanation of your battery. In its present form your communication is too much of an advertisement.

We have duly received Mr. LEMON'S communications from New Zealand.

MR. EDWARDS.—We have not the information you require.